The Seasat-A Scanning Multichannel Microwave Radiometer

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Abstract

A Scanning Multichannel Microwave Radiometer (SMNR) has been designed for the Nimbus- G Spacecraft and incorporated also into the Seasat-A payload for the primary purpose of determining sea surface temperatures and wind stress on a nearly all-weather basis. Observations of microwave polarization components will be made at wavelengths of 0.8, 1.4, 1.7, 2.8, and 4.6 cm over a swath 577 km wide below the Seasat A spacecraft. The smallest spatial resolution cell is 15 x 23 km at a wavelength of 0.8 cm, and proportionately larger at the other wavelengths. Using experimentally determined algorithms for converting the observed brightness temperatures, the indicated accuracies of the results (excluding conditions of significant rainfall) are within 1K for sea surface temperature and 2 m/sec for surface wind speeds, over a range from 0-50 m/sec.

error estimates apply only to the instrument contribution to the total error; the fact that linear regression fits have been made to non-linear phenomena will also contribute to the total error in the determinations. This latter factor can be controlled by limiting the allowable range of parameter values in a given data inversion.

If T_s and v are assumed to be constant over the entire 4.6 cm wavelength spatial resolution cell, the values obtained from Equation (10) could be used in Equation (7) to solve for the atmospheric opacity at each of the five wavelengths. The atmospheric parameters of water vapor content, liquid water content, and rainfall rate could be deduced from the values of the individual opacities and their ratios. In addition, if the opacities are sufficiently small at the shorter wavelengths, the 0.81 cm and 1.7 cm channels could be used as illustrated in Equations (8) (10) to obtain sea surface temperature and 20 meter wind speeds within a smaller resolution cell (but at reduced sensitivities) i.e., within a 46 km cell rather than a 125 km cell. This and a number of other alternative approaches will be evaluated further before a final selection is made of the algorithms to be used for routine processing of the SMMR data.

5. Conclusions

A multi-spectral passive microwave imager has been designed and is under construction with sensitivities sufficient for accurate determinations of sea surface temperature, wind speeds, atmospheric liquid water content, water vapor, and rainfall rates over oceans. Based on demonstrated noise figures of the radiometer components and *a priori* knowledge of the parameters at a given geographical location, it is estimated that ocean surface temperature determinations can be made with an accuracy as good as half a degree Kelvin and wind speed determinations within half a meter per second, with the precautionary that these estimates assume that a good linear fit can be made to the dependence of microwave brightness temperatures on these parameters. This assumption may not be valid for the wind speed determination, as has been discussed in the text.

The SMMR represents the first opportunity for obtaining important oceanic parameters on a nearly all-weather basis from spacecraft-borne remote sensors. The spatial resolution available with the SMMR is not as good as would be desired for some applications. However, the SMMR does provide an important first step in the development of larger instruments to be carried on future spacecraft, e.g., the Shuttle, which can carry larger microwave antennas. Such instruments are under development at this time.

The development of algorithms for the SMMR is certainly not complete at this point. Prior to the launch of Nimbus-G and Seasat-A, extensive additional experiments on board aircraft along with *in situ* comparative measurements will be carried out. It is anticipated that improved radiometers on board the aircraft, better techniques for obtaining surface wind speeds, and a broader statistical data base will all contribute to a better definition of the constants involved in the linear regressions discussed above. Future work in this area will be a cooperative effort with the members of the experiment teams for both the Nimbus-G SMMR and the Seasat-A SMMR.

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